WHAT IS CLAIMED IS:

1. A shift control apparatus of an automatic transmission of a motor vehicle to which a torque is transmitted from an engine via a fluid coupling device, the automatic transmission including a plurality of hydraulically operated friction elements, wherein a clutch-to-clutch downshift is carried out during coasting of the vehicle by releasing one of the friction elements as a release-side friction element and engaging another of the friction elements as an engagement-side friction element, comprising:

a speed difference detecting unit that detects a difference between input and output rotation speeds of the fluid coupling device; and

a minimal driving state controller that increases an engine speed by a controlled amount based on the difference between the input and output rotation speeds detected by the speed difference detecting unit when the clutch-to-clutch downshift is carried out during coasting of the vehicle, so that the vehicle is brought into a minimal driving state in which the engine speed is slightly higher than the output rotation speed of the fluid coupling device.

2. The shift control apparatus according to claim 1, wherein the minimal driving state controller determines an amount of increase of the engine speed for establishing the minimal driving state of the vehicle, such that the amount of increase of the engine speed decreases with an increase in an average value of the difference between the input and output rotation speeds of the fluid coupling device within a predetermined period.

3. The shift control apparatus according to claim 1, wherein the minimal driving state controller determines an amount of increase of the engine speed for establishing the minimal driving state of the vehicle such that the amount of increase of the engine speed is reduced as a vehicle speed decreases.

4. The shift control apparatus according to claim 3, wherein the amount of increase of the engine speed is reduced in real time at a rate that is

determined based on a rate of decrease of the vehicle speed.

5. The shift control apparatus according to claim 1, further comprising:

a synchronization determining unit that determines whether synchronization of rotation of the engagement-side friction element associated with the clutch-to-clutch downshift is accomplished; and

an engaging pressure controller that quickly increases an engaging pressure for the engagement-side friction element from an initial pressure that has been established, when the synchronization determining unit determines the synchronization of rotation of the engagement-side friction element.

6. The shift control apparatus according to claim 5, wherein the initial pressure of the engaging pressure for the engagement-side friction element is determined based on the difference between input and output rotation speeds of the fluid coupling device and a vehicle speed.

7. The shift control apparatus according to claim 1, further comprising:

a rapid braking determining unit that determines whether the vehicle is being rapidly braked; and

a minimal driving state stopping unit that immediately stops a control of increasing the engine speed for establishing the minimal driving state of the vehicle, the control having been performed since a command signal for a previous coast downshift was generated, when the rapid braking determining unit determines that the vehicle is being rapidly braked.

8. The shift control apparatus according to claim 1, wherein the minimal driving state controller starts increasing the engine speed by the controlled amount for establishing the minimal driving state, at around the time of a start of an inertia phase of the clutch-to-clutch downshift effected during coasting of the vehicle.

9. The shift control apparatus according to claim 8, wherein the start of the inertia phase of the clutch-to-clutch downshift is determined by detecting a point of time when the output rotation speed of the fluid coupling device starts increasing.

10. A shift control apparatus of an automatic transmission of a motor vehicle in which a coast downshift is carried out during coasting of the vehicle, the automatic transmission including a plurality of hydraulically operated friction elements, the shift control apparatus comprising:

a shift controller that causes the coast downshift to be carried out while the vehicle is kept in a minimal driving state in which an engine speed is slightly higher than an input shaft speed of the automatic transmission; and

a hydraulic pressure setting unit that sets a hydraulic pressure applied to at least one of the friction elements associated with the coast downshift during a shifting period, according to the minimal driving state.

11. The shift control apparatus according to claim 10, wherein:

the coast downshift is a clutch-to-clutch downshift effected by releasing one of the friction elements as a release-side friction element and engaging another of the friction engaging elements as an engagement-side friction element; and

the hydraulic pressure setting unit determines an initial pressure of the release-side friction element and an initial pressure of the engagement-side friction element, according to the minimal driving state.

12. The shift control apparatus according to claim 11, further comprising:

an input and output rotation speed detecting unit that detects input and output rotation speeds of a fluid coupling device provided between the automatic transmission and an engine,

wherein the hydraulic pressure setting unit sets the initial pressures of the release-side friction element and the engagement-side friction element, based on the input and output rotation speeds of the fluid coupling device detected by the

input and output rotation speed detecting unit.

13. The shift control apparatus according to claim 11, further comprising a braking-time correcting unit that increases an engaging pressure for the engagement-side friction element in real time in accordance with a decelerating state of the vehicle while the vehicle is being braked.

14. The shift control apparatus according to claim 11, wherein a parameter associated with an engaging pressure for the engagement-side friction element is corrected based on a temperature of a working oil supplied to the engagement-side friction element.

15. The shift control apparatus according to claim 11, wherein a parameter associated with an engaging pressure for the release-side friction element is corrected based on a temperature of a working oil supplied to the release-side friction element.

16. A shift control apparatus of an automatic transmission of a motor vehicle in which a coast downshift is carried out during coasting while the vehicle is kept in a minimal driving state in which an engine speed is slightly higher than an input shaft speed of the automatic transmission, the automatic transmission including a plurality of hydraulically operated friction elements, comprising:

a hydraulic pressure controller that controls a hydraulic pressure applied to at least one of the friction elements associated with the coast downshift during a shifting period, according to the minimal driving state; and

a learning controller that corrects, by learning, the hydraulic pressure for the at least one friction element set by the hydraulic pressure controller during the shifting period.

17. The shift control apparatus according to claim 16, further comprising:

a speed difference detecting unit that detects a difference between input

and output rotation speeds of a fluid coupling device provided between the automatic transmission and an engine of the vehicle,

wherein the hydraulic pressure controller sets an initial pressure of the at least one friction element associated with the coast downshift during the shifting period, based on the difference between the input and output rotation speeds of the fluid coupling device.

18. The shift control apparatus according to claim 17, wherein:

the coast downshift is a clutch-to-clutch shift effected by releasing one of the friction elements as a release-side friction element and engaging another of the friction elements as an engagement-side friction element substantially at the same time; and

the learning controller determines a tie-up condition of the clutch-to-clutch shift based on a temporary increase in the output rotation speed of the fluid coupling device, and corrects an engaging pressure for the engagement-side friction element by learning, depending upon the tie-up condition.

19. The shift control apparatus according to claim 18, wherein:

the learning controller determines that the clutch-to-clutch shift involves a strong tie-up condition when determining that the temporary increase in the output rotation speed of the fluid coupling device becomes substantially equal to zero, and that the input rotation speed of the fluid coupling device exceeds the output rotation speed thereof again after the input rotation speed falls below the output rotation speed from a condition in which that the input rotation speed is higher than the output rotation speed; and

the learning controller determines that the clutch-to-clutch shift involves a weak tie-up condition when determining that the temporary increase in the output rotation speed of the fluid coupling device becomes substantially equal to zero, and that the input rotation speed of the fluid coupling device is kept higher than the output rotation speed.

20. The shift control apparatus according to claim 18, wherein the

learning controller corrects, by learning, an engaging pressure for the release-side friction element so that a period between a start of the clutch-to-clutch shift and a start of slipping of the release-side friction element during the clutch-to-clutch shift becomes equal to a predetermined target period.

21. The shift control apparatus according to claim 18, wherein the learning controller corrects, by learning, an engaging pressure for the engagement-side friction element when a temporary increase in the output rotation speed of the fluid coupling device is larger than a predetermined value.

22. The shift control apparatus according to claim 16, further comprising:

a rapid braking state determining unit that determines whether the vehicle is being rapidly braked; and

a learning inhibiting unit that inhibits learning by the learning controller when the rapid braking state determining unit determines that the vehicle is rapidly braked.

23. A method for controlling shifting of an automatic transmission of a motor vehicle to which a torque is transmitted from an engine via a fluid coupling device, the automatic transmission including a plurality of hydraulically operated friction elements, wherein a clutch-to-clutch downshift is carried out during coasting of the vehicle by releasing one of the friction elements as a release-side friction element and engaging another of the friction elements as an engagement-side friction element, the method comprising the steps of:

detecting a difference between input and output rotation speeds of the fluid coupling device; and

increasing an engine speed by a controlled amount based on the difference between the input and output rotation speeds when the clutch-to-clutch downshift is carried out during coasting of the vehicle, so that the vehicle is brought into a minimal driving state in which the engine speed is slightly higher than the output rotation speed of the fluid coupling device.

24. The method according to claim 23, wherein an amount of increase of the engine speed for establishing the minimal driving state of the vehicle is determined such that the amount of increase of the engine speed is reduced as a vehicle speed decreases.

25. The method according to claim 23, further comprising the steps of:

determining whether synchronization of rotation of the engagement-side friction element associated with the clutch-to-clutch downshift is accomplished; and

quickly increasing an engaging pressure for the engagement-side friction element from an initial pressure that has been established, when the synchronization of rotation of the engagement-side friction element is determined.

26. The method according to claim 23, further comprising the steps of:

determining whether the vehicle is being rapidly braked; and

immediately stopping a control of increasing the engine speed for establishing the minimal driving state of the vehicle, the control having been performed since a command signal for a previous coast downshift was generated.

27. The method according to claim 23, wherein the step of increasing the engine speed by the controlled amount for establishing the minimal driving state is started at around the time of a start of an inertia phase of the clutch-to-clutch downshift effected during coasting of the vehicle.

28. A method for controlling shifting of an automatic transmission of a motor vehicle in which a coast downshift is carried out during coasting of the vehicle, the automatic transmission including a plurality of hydraulically operated friction elements, the method comprising the steps of:

causing the coast downshift to be carried out while the vehicle is kept in a minimal driving state in which an engine speed is slightly higher than an input shaft speed of the automatic transmission; and

setting a hydraulic pressure applied to at least one of the friction elements

associated with the coast downshift during a shifting period, according to the minimal driving state.

29. The method according to claim 28, wherein:

the coast downshift is a clutch-to-clutch downshift effected by releasing one of the friction elements as a release-side friction element and engaging another of the friction engaging elements as an engagement-side friction element; and

the step of setting a hydraulic pressure comprises setting an initial pressure of the release-side friction element and an initial pressure of the engagement-side friction element according to the minimal driving state.

30. The method according to claim 29, further comprising the step of:

detecting input and output rotation speeds of a fluid coupling device provided between the automatic transmission and an engine,

wherein the initial pressures of the release-side friction element and the engagement-side friction element are set based on the input and output rotation speeds of the fluid coupling device.

31. The method according to claim 29, further comprising the step of increasing an engaging pressure for the engagement-side friction element in real time in accordance with a decelerating state of the vehicle.

32. A method for controlling shifting of an automatic transmission of a motor vehicle in which a coast downshift is carried out during coasting while the vehicle is kept in a minimal driving state in which an engine speed is slightly higher than an input shaft speed of the automatic transmission, the automatic transmission including a plurality of hydraulically operated friction elements, comprising the steps of:

controlling a hydraulic pressure applied to at least one of the friction elements associated with the coast downshift during a shifting period, according to the minimal driving state; and

correcting, by learning, the hydraulic pressure for the at least one friction

element during the shifting period.

33. The method according to claim 32, further comprising the step of:

detecting a difference between input and output rotation speeds of a fluid coupling device provided between the automatic transmission and an engine of the vehicle,

wherein the step of controlling a hydraulic pressure comprises setting an initial pressure of the at least one friction element associated with the coast downshift during the shifting period, based on the difference between the input and output rotation speeds of the fluid coupling device.

34. The method according to claim 33, wherein:

the coast downshift is a clutch-to-clutch shift effected by releasing one of the friction elements as a release-side friction element and engaging another of the friction elements as an engagement-side friction element substantially at the same time; and

a tie-up condition of the clutch-to-clutch shift is determined based on a temporary increase in the output rotation speed of the fluid coupling device, and an engaging pressure for the engagement-side friction element is corrected by learning, depending upon the tie-up condition.

35. The method according to claim 34, wherein:

a strong tie-up condition of the clutch-to-clutch shift is determined when it is determined that the temporary increase in the output rotation speed of the fluid coupling device becomes substantially equal to zero, and that the input rotation speed of the fluid coupling device exceeds the output rotation speed thereof again after the input rotation speed falls below the output rotation speed from a condition in which that the input rotation speed is higher than the output rotation speed; and

a weak tie-up condition of the clutch-to-clutch shift is determined when it is determined that the temporary increase in the output rotation speed of the fluid coupling device becomes substantially equal to zero, and that the input rotation

speed of the fluid coupling device is kept higher than the output rotation speed.

36. The method according to claim 34, wherein an engaging pressure for the release-side friction element is corrected by learning so that a period between a start of the clutch-to-clutch shift and a start of slipping of the release-side friction element during the clutch-to-clutch shift becomes equal to a predetermined target period.

37. The method according to claim 32, further comprising the steps of:

determining whether the vehicle is being rapidly braked; and

inhibiting correction of the hydraulic pressure by learning when it is determined that the vehicle is rapidly braked.